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ORIGINAL ARTICLE

Investigation of organizational and hygiene features in dentistry: a pilot study

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Key words

Dentistry • Infection risk

Summary

Introduction. *In dentistry, as in surgery, there is a risk of cross-infection for both patients and staff. The aim of this research was to evaluate procedures and behaviors enacted by dental staff which might engender a risk for themselves and their patients.*
Methods. *A questionnaire was administered to 106 dental workers in Genoa (Italy), both public and private. Whenever personal interviews were conducted, the facilities involved were also inspected and the activities of the dental staff were observed directly.*
Results. *This research highlighted some critical points in both structural and organizational features and in the management of infective hazards in the sample considered. In some cases, inadequacies were noted with regard to the prevention of cross-infections, such as the lack of disinfection of work surfaces and the handles of chair-set accessories.*
Discussion and conclusions. *The particular nature of dental work, in which aerosols of blood and saliva may be produced by rotating instruments, engenders a risk of infection. Application of the various preventive measures available can significantly reduce microbial contamination and the risk of occupational infection and cross-infections. Furthermore, improvement in the structural and organizational features of dental surgeries and the continuing education of health-care workers is indispensable to the control and prevention of infectious diseases.*

Introduction

Dental health-care workers and their patients may be exposed to a variety of microorganisms, including cytomegalovirus, Hepatitis B virus (HBV), Hepatitis C virus (HCV), *Herpes simplex* virus types 1 and 2, Human immunodeficiency virus (HIV), *Mycobacterium tuberculosis*, staphylococci, streptococci, and other viruses and bacteria [1, 2]. The spread of infections in dental settings may take place directly through contact with blood, oral fluids or other secretions; indirectly through contact with contaminated instruments, operating equipment or environmental surfaces; and through inhalation or contact with microorganisms present in aerosols or spatters of oral and respiratory fluids or in dental unit waterlines. Aerosols and spatters are produced by various instruments used in dentistry, such as turbines, micro-motors, air-water syringes and ultrasound scalers [3-5]. The particulate released from the patient's mouth and throat includes: saliva, nasal and throat secretions, dental plaque, blood, tooth tissues, materials used for dental treatment and microbes [6-8]. Although the existence of dental and microbiological aerosols has long been known, the scientific analysis of the role they play in dentistry has only recently been investigated [9]. Aerosols can remain airborne for long periods of time and may be inhaled by dental staff and patients [10]; they then tend to settle, contaminating surfaces, operating equipment, etc. A study conducted by Prospero et al. evaluated the sedimenting bacterial load in dental practice during routine procedures; this revealed contamination by *Streptococcus* species (42%), *Staphylococcus* species (41%), and gram-negative bacteria (17%). The surfaces that showed the highest levels of contamination were, in decreasing order, dental healthcare workers' surgical masks, lamps, areas near spittoons, and mobile trays. Rautemaa et al. found significant contamination in samples taken in dental cubicles at all distances from the operating field when high-speed instruments were used (mean 970 colony-forming units/m^2/h) [11].

The microorganisms released into the environment in aerosol form may come directly from dental staff or the patient being treated, or from previously contaminated dental unit waterlines; microbiological studies on samples of dental unit water from 150 sites have revealed unacceptably high levels of microbial contamination [12], and the biofilm that forms on the walls of waterlines has been seen to be mainly responsible for this [13]. Such contamination may be caused by the water supply itself or, more probably, through the aspiration of microbes from the patient's mouth (back-contamination). Although the presence of high concentrations of microorganisms in the water of dental units is a phenomenon that is now recognized by the scientific community, the prevention of the spread of infections through this route is yet to become an established common practice among dental health-care workers.

In dentistry, several factors contribute to the increased risk of cross-infection. The operator's face is in close proximity to that of the patient, and therefore to the

source of aerosols; this increases the possibility that potentially pathogenic microorganisms may be taken in through the operator's conjunctiva and airways, even if the face is protected. Indeed, some epidemiological studies have found a greater concentration of serum antigen and antibodies for HBV [14-16], HCV [17, 18] and *Legionella* [19] in dentists than in the general population. Moreover, most dental facilities are not equipped with a ventilation system that can ensure an adequate number of hourly air exchanges (most dental facilities have air-conditioning systems that simply cool the air, or rely on natural ventilation). As a result, aerosol particles and any pathogens they contain may remain in the air for long periods. Other important factors are: the use of instruments that produce aerosols, the high frequency of dental operations in the population, and the operating field; indeed, the mouth and throat constitute an extremely complex biological environment made up of numerous anatomical structures harboring various species of microorganisms. For instance, on PCR testing, Maticic et al. found HCV RNA in 35% of saliva samples and 59% of gingival secretion samples taken from patients with hepatitis C [20].
The aim of the present study was to assess, in a sample of dentists working in hospitals and private practices, the knowledge, behavior and procedures utilized for the control and prevention of cross-infections.

Methods

A questionnaire was drawn up for administration to dental health-care workers operating in the public and private sectors. The questions concerned personal data, knowledge of the risks of infection and their prevention, the structural, technological and organizational features of dental surgeries, the use of disinfectants, the methods of sterilization adopted, etc. The questionnaire was subdivided into two sections: the first was aimed at gathering information on the dental facility considered (e.g. number of cubicles, surface area of each cubicle, characteristics of the walls and floor, etc), while the second focused on the risk of infection for both staff and patients.
Each questionnaire was accompanied by an introductory letter explaining the salient points of the investigation. Moreover, it was pointed out that the survey was not an inspection, that participation was voluntary, and that the results would be reported only in aggregate form, the aim being to shed light on the control and prevention of infections.
The questionnaire was administered (in order to validate its efficacy) to a sample of dental health-care workers in Genoa (Italy). Specifically, it was administered directly, by interview, to 26 dentists (in both the public and private sectors), and was sent by post to another 150 randomly (simple randomization) selected dentists working in private practice. A total of 176 questionnaires were distributed. On the same days as the questionnaire was administered directly, the respective dental facilities were inspected and the activities of the interviewees were observed. The data collected were recorded in an electronic archive and elaborated by means of the STATA SE9™ program.

Results

Of the 150 dental health-care workers to whom the questionnaire was sent by post, only 80 (53.3%) responded by returning the questionnaire to the data-collection centre. All 26 dentists directly interviewed have answered. All the questionnaires returned were deemed valid in that they had been filled in correctly.
The respondents provided information about their private practices in 81.1% of cases, and about their hospital activity in the remaining 18.9% of cases.

Structural and organizational features of the dental facilities

In public facilities, the number of dental cubicles located within the same macro-environment was seen to range from 3 to 8, and in private surgeries, from 1 to 3. The mean surface area of each cubicle was about 15 m^2; in all cases, each cubicle was equipped with a single dental chair-set.
A designated area/room was available for the storage of clean materials in 66% of the facilities considered; for the storage of dirty materials in 84% of cases, and in only 39.6% for the storage of sterile materials. The availability of a dedicated area for the collection, cleaning and preparation of instruments was reported by 84% of respondents; in 92.5% of cases, an area was specifically allocated to sterilization, while in the remaining 7.5% of cases contaminated garments and instruments were sent to an outside facility for sterilization.
With regard to the walls and floors of the dental cubicles and the rooms/areas used for washing and sterilization, it was found that in only 34% of cases the walls were suited to washing and disinfection up to a height of 200 cm from the floor (i.e. smooth surface and concave fillet between wall and floor). In 67.9% of cases, the floors were resistant to the various chemical and physical agents used in disinfection.

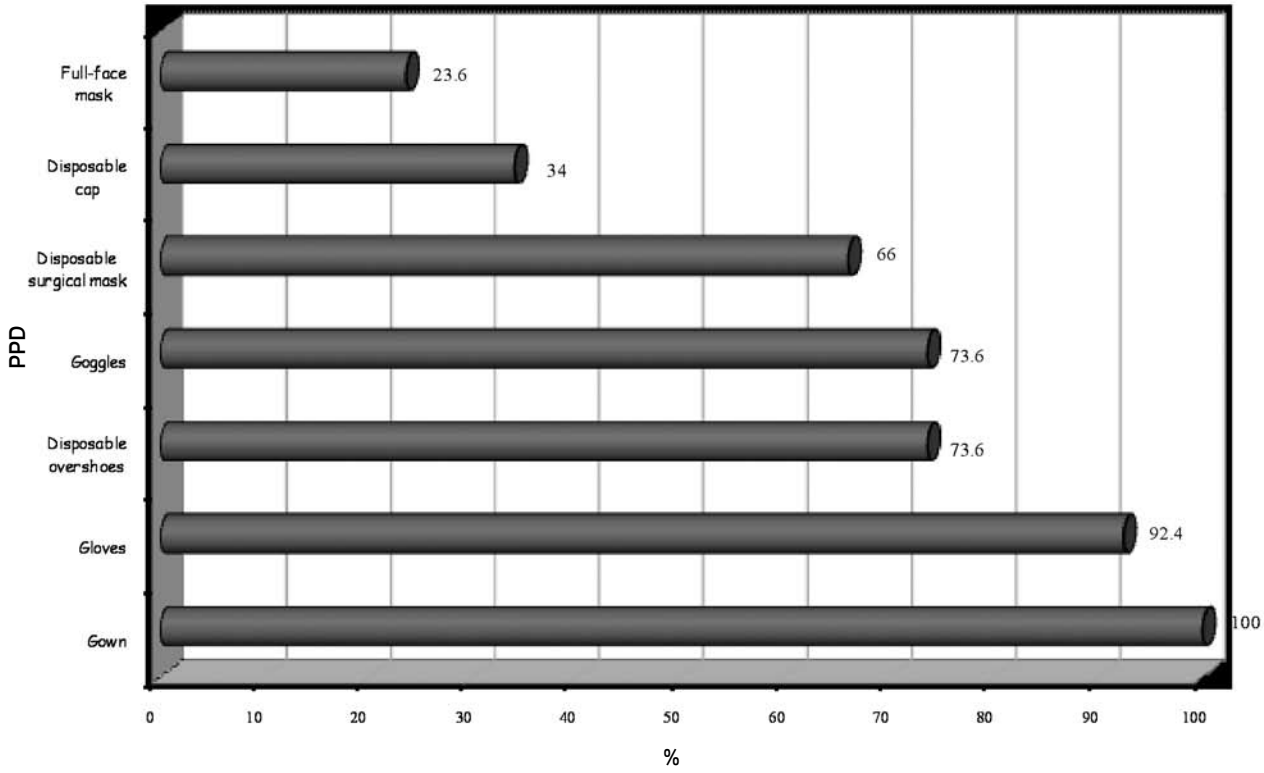
Personnel data

10.4% of respondents were 30 years old or younger; 73.6% were between 30 and 50 years old, and 16% were over 50. The mean number of patients treated each day was less than 10 in 26.4% of cases, between 10 and 20 in 36.8%, and above 20 in the remaining cases.

Infection risk and prevention

The questionnaires revealed that most dentists (86.8%) had been vaccinated against HBV. Moreover, 73.6% of respondents stated that they always took the patient's medical history; 7.5% reported doing so occasionally, and 18.9% did so only in suspect cases. All patients were regarded by 54.7% of dentists as being potentially infected; some dentists, however, reported that they

Fig. 1. Percentage use of the most common personal protection devices (PPD).



used more personal protection devices (PPD) if they had to treat a patient who was infected or suspected of being so.

It emerged that 97.2% of dental health-care workers washed their hands, though for the most part only with ordinary detergent, both before and after treating each patient; only 7.5% reported using a disinfectant detergent.

The data regarding the use of PPD revealed that the most frequently used were gowns and gloves, followed by disposable overshoes, goggles and surgical masks; the use of surgical caps and full-face masks was less often reported (Fig. 1). The reuse of these PPD during the treatment of several successive patients was also evaluated. It emerged that gloves were the only PPD that were always changed by all dentists between one patient and the next. With regard to gowns, footwear and goggles,

Tab. I. Percentage of affirmative replies regarding the presence of sterilization devices (and their controls) and of other systems to prevent cross-infections.

Equipment of the dental facilities	%
Sterilization devices	
Autoclaves	91.5
Ultrasound devices	60.4
Quartz bead sterilizers	5.7
Chemiclaves	0
Dry stoves	0
Boilers	0
UV lamps	0
Sterilization control of autoclaves	
External and internal indicators	52.8
Biological tests	36.8
Bowie-Dick test	2.8
Other systems of prevention	
High-volume evacuator	94.3
Low-volume evacuator	60.4
Washbasins with non-manual (electric, pedal or elbow) controls	54.7
Ventilation system (> 6 air exchanges /h)	23.6

the percentages of reuse were 81.1%, 73.6% and 64.1%, respectively; a considerable percentage of operators (36.8%) reported reusing surgical masks, while caps and full-face masks were reused in 31.1% and 10.4% of cases, respectively.
In addition, procedures for the decontamination of presterilized and non-sterilizable instruments were also analyzed. These instruments were always washed and disinfected; in no case were they only washed by hand or only disinfected, much less left untreated altogether. The main procedures used to sterilize contaminated instruments and any further methods of prevention were recorded (Tab. I).

Features of dental chair-sets and their management

All interviewees stated that they used dental chair-sets which conform to EU norms: i.e. equipped with a turbine-driven water system, micro-motor, tartar ablators and disposable or sterilizable tips, air-water syringe and surgical aspiration cannulae.
With regard to devices for the control of water-line contamination, 81.1% of systems were fitted with filters, 13.2% with anti-reflux valves and 7.5% with self-decontamination devices; only 5.7% of the dentists stated that they did not use any water treatment device.
Table II shows the percentages recorded with regard to the disinfection of the various components of the dental chair-set, both between patients and at the end of the working day: 7.9% and 15.8% of respondents stated that they did not disinfect the handles of the chair-set accessories and exposed work surfaces, respectively, because these were protected by transparent film or cloths; in 71% of cases, these protective devices were changed between one patient and the next.

Discussion and conclusions

The present study surveyed a sample of dental health-care workers in order to investigate the structural and organizational characteristics of dental facilities in Italy and, especially, to pick out and quantify procedures and behaviors that might constitute a risk for both operators and patients.
The Center for Disease Control and Prevention (CDC) has issued specific guidelines [21] for the prevention and control of infections in dental settings. These guidelines stress the use of "standard precautions", a term which has now replaced "universal precautions", for the prevention of exposure to blood-borne pathogens, and also other pathogens that can be spread by any other body fluid, excretion or secretion.
In reality, the most efficacious preventive approach must be based on a combination of actions, such as immunization (where possible), the use of barrier systems and strict adherence to the routine procedures of infection control. With regard to vaccination against blood-borne viruses, the questionnaires revealed that 13.2% of dental health-care workers had not been vaccinated against HBV. Moreover, 23.1% of those who were interviewed directly reported that they had been vaccinated several years earlier but had not undergone quantitative assay of anti-HB antibodies to ascertain their antibody status.
At the present time, the impossibility of implementing immunoprophylaxis for HIV and HCV means that the only valid strategy for preventing occupational infection by these viruses is to avoid exposure. The use of personal protective devices is particularly important as it is not always possible to determine the true infective status of the patient from a self-reported history and/or clinical examination [1]. It emerges from the present study that the use of PPD varies considerably according to the type of device, with only gowns being used 100% of the time. Gloves, which are an extremely important PPD, are not used by some 7.6% of interviewees. Given that the dentist's face is in close proximity to the patient's mouth, the skin and mucosa are at risk of exposure to infective agents carried by aerosols or spatters of blood and saliva. To minimize this risk, a fair number (73.6%) of dentists use goggles; by contrast, the full-face mask is little used, as it is considered to be an uncomfortable nuisance.
In the survey, 94.3% of respondents reported having a high-volume evacuator. These devices are extremely useful in preventing infections in dental settings, as they intercept the spray generated by the turbine, micro-motor or ablator before it reaches the floor or the operator. Unfortunately, however, although this device is a routine piece of equipment in dental operatories, is probably the safeguard that is used least often [22].
In order to minimize microbiological pollution, it is very important that dental facilities be equipped with an air-

Tab. II. Percentage of affirmative replies regarding disinfection of the various components of the chair-set and exposed surfaces.

Substrate disinfected between one patient and the next	%
Handle of air-water syringe	81.1
Handle of micro-motor	81.1
Handle of turbine	81.1
Exposed work surfaces	73.6
Substrate disinfected at the end of the working day	**%**
Handle of air-water syringe	84
Handle of micro-motor	84
Handle of turbine	84
Exposed work surfaces	79.2

conditioning system that can ensure an adequate number of air changes per hour. Nevertheless, only 23.6% of our respondents reported having a ventilation system.
A dental worker may be infected not only through aerosols produced during a procedure on an infected patient, but also through aerosolized water from a previously infected waterline. Indeed, pathogenic microorganisms (including blood-borne viruses) from the mouth and throat of the patient may enter the waterline by means of capillary action or back-aspiration; the spray generated by the turbine, air-water syringe, ultrasound ablator and micro-motor may then contaminate the operator and subsequent patients [23].
Our data on water systems and their management have shown that filtered water was used by 81.1% of the dentists; many of those interviewed directly stated that they used filters essentially to prevent the system from being blocked by the debris (dental or material) produced during the various dental procedures. However, these filters are not cleaned or replaced at regular intervals, but only when they show signs of blockage.
The CDC [21] has underlined the importance of thoroughly sanitizing surfaces, not only at the end of the working day, but also between one patient and the next.
The results of the present study revealed that not all of the respondents disinfect the handles of the chair-set accessories or exposed works surfaces, either between one patient and the next or at the end of the working day. The American Dental Association (ADA) has recommended sterilization of the handpieces for each patient [24].
Disinfection between patients should be made as easy as possible and should extend to all contaminated areas. Some authors maintain that it is the dentist's responsibility to recognize susceptible patients and to take the necessary steps to avoid any possibility of cross-infection [25]. In reality, however, such precautions should always be taken, as patients may be unaware of, or unwilling to divulge, their own infective status [26]. Only 54.7% of our respondents regard all patients as potentially infected.

In conclusion, although various measures can be taken to prevent infection in dental settings [21], the results of this study show that dental workers have not yet become fully aware of the need to do so. This failure to adopt all effective measures to prevent and control cross-infections, could depend on the hurry due to the high frequency of dental operations in the same day and therefore to inadequate planning of the working day.
Indeed, dental surgeries should be seen more as operating theatres than as offices [11], and appropriate measures to prevent cross-infections should therefore be rigorously adopted.
In fact in dentistry, as in other health-care settings, there is a risk of pathogens being transmitted from one patient to another. This risk stems from the particular characteristics of the operating field. Indeed, the fluids present in the oral cavity may be heavily contaminated by viruses and bacteria; moreover, contamination may be caused by micro-organisms in the nose, throat and respiratory tree [3], and, in the case of micro-lesions of the gum, by blood-borne pathogens. Any dental operation that produces aerosols of saliva or blood therefore constitutes a potential risk of microbial contamination of the air and surfaces, and may expose dental patients to pathogens. How far these aerosols spread and what level of contamination they cause in the dental surgery has become a growing concern as the number of patients with oro-nasal meticillin-resistant *Staphylococcus aureus* colonization has increased [11].
Furthermore specific training for medical and paramedical dental staff should prove effective. However, a crucial element in the success of "training for prevention and safety" is the development of *learning with commitment*, i.e. involvement that is motivated by the will to improve.
The present research constitutes only the preliminary phase of a more extensive study that is to be conducted nationwide, and which will have the further aim of determining whether there are differences between dental staff operating in the public sector and those operating in the private sector.

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